CLAIMS

1. An improved Wavefront Coding system for imaging an object comprising:

Wavefront Coding Optics having an aperture and including -

a central region, wherein the central region applies an essentially constant phase profile to light from the object passing through the central region, and

a peripheral region disposed about the central region, wherein the peripheral region applies a phase profile to light from the object that has alternating increasing and decreasing phase relative to the central region,

wherein the phase profile applied by the Wavefront Coding Optics is aspheric and rotationally asymmetric, and

wherein the phase profile applied by the Wavefront Coding Optics alters the optical transfer function of the Wavefront Coding system in such a way that the altered optical transfer function is substantially less sensitive to focus related aberrations than was the unaltered optical transfer function;

a detector for capturing an image from the Wavefront Coding Optics; and

a post processing element for processing the image captured by the detector by reversing the alteration to the optical transfer function of the Wavefront Coding system accomplished by the Wavefront

Coding Optics.

2. The Wavefront Coding system of claim 1, wherein the central region comprises a rectangular aperture, and the peripheral region forms a rectangular frame around the central region.

3. The Wavefront Coding system of claim 1, wherein the central region comprises a circular aperture, and the peripheral region forms a ring around the central region.

4. The Wavefront Coding system of claim 1, wherein the central region comprises a rectangular aperture, and the peripheral region forms a ring around the central region.

5. The Wavefront Coding system of claim 1, wherein the peripheral region comprises more than one concentric zone.

6. The Wavefront Coding system of claim 1, wherein the phase profile applied by the Wavefront Coding Optics substantially follows the function:

$$\text{phase}(x,y) = \Sigma\ [\ U(|x|/A_{xi})\ \ G_{xi}(x) + U(|y|/A_{yi})\ \ G_{yi}(y)\ ]$$

where

$$|x| \leq 1,\ |y| \leq 1$$

$$i = 1, 2, \ldots, N$$

and where $U(z) = 1$ if $z \geq 1$, $U(z) = 0$ otherwise

$$0<A_{xi}<1,\ 0< A_{yi} <1$$

and where the sum is over the index i.

7. The Wavefront Coding system of claim 1, wherein the peripheral region of the Wavefront Coding Optics applies substantially linear functions.

8. The Wavefront Coding system of claim 7, wherein the phase profile applied by the Wavefront Coding Optics substantially follows the phase function:

$$\text{phase}(x,y) = U(|x|/A_x) * \text{sign}(x)(|x|-A_x)/(1-A_x)$$

$$+ U(|y|/A_y) * \text{sign}(y)(|y|-A_y)/(1-A_y)$$

where

$$|x| \le 1,\ |y| \le 1$$

$$U(z) = 1 \text{ if } z \ge 1,\ U(z) = 0 \text{ otherwise}$$

$$\text{sign}(z) = +1 \text{ for } z \ge 0,\ \text{sign}(z) = -1 \text{ otherwise}$$

$$0<A_x<1,\ 0< A_y <1.$$

9. The Wavefront Coding system of claim 1, wherein the Wavefront Coding Optics peripheral region applies substantially the sum of powers region phase function:

$$\text{phase}(x,y) = \Sigma\ U(|x|/A_{xi})\ \alpha_i\ \text{sign}(x)\ [\ (|x| -A_{xi})/(1-A_{xi})\ ]^{\beta i}$$

$$+ \Sigma\ U(|y|/A_{yi})\ \chi_i\ \text{sign}(y)\ [\ (|y| -A_{yi})/(1-A_{yi})\ ]\delta^i$$

where

$$|x| \le 1,\ |y| \le 1,\ i = 1, 2, \ldots, N$$

$$U(z) = 1 \text{ if } z \ge 1,\ U(z) = 0 \text{ otherwise,}$$

$$\mathrm{sign}(z) = +1 \text{ for } z \ge 0,\ \mathrm{sign}(z) = -1 \text{ otherwise,}$$

$0<A_{xi}<1$, $0< A_{yi} <1$, and where the summations are over the index i.

10. The Wavefront Coding system of claim 9, wherein the Wavefront Coding Optics peripheral region applies substantially the cubic function:

$$\mathrm{phase}(x,y) = U(|x|/A_x)\ \alpha_i\ \mathrm{sign}(x)\ [\ (|x| - A_x)/(1-A_x)\ ]^3 +$$

$$U(|y|/A_y)\ \chi_i\ \mathrm{sign}(y)\ [\ (|y| - A_y)/(1-A_y)\ ]^3$$

where

$$|x| \le 1,\ |y| \le 1,$$

$$U(z) = 1 \text{ if } z \ge 1,\ U(z) = 0 \text{ otherwise,}$$

$$\mathrm{sign}(z) = +1 \text{ for } z \ge 0,\ \mathrm{sign}(z) = -1 \text{ otherwise,}$$

$$0<A_{xi}<1,\ 0< A_{yi} <1.$$

11. The Wavefront Coding system of claim 1, wherein the Wavefront Coding Optics peripheral region applies substantially the function:

$$\mathrm{phase}(\rho,\theta) = \Sigma\ Q(\rho/\underline{\Omega_i})\ \ G_i(\ \rho,\theta\ )$$

where

$$|\rho| \le 1,\ 0 \le \theta \le 2\,\mathrm{pi}$$

$$i = 1, 2, \ldots N$$

where

$$Q(z) = 1 \text{ if } z \ge 1,\ Q(z) = 0 \text{ otherwise}$$

$$0 < \underline{\Omega}_i < 1$$

and where the sum is over the index i.

12. The Wavefront Coding system of claim 11, wherein the the phase profile applied by the Wavefront Coding Optics substantially follows the function:

$$\mathrm{phase}(\rho,\theta) = \Sigma\ Q(\rho/\Omega_i)\ \alpha_i\ \rho^{\beta i} \cos(\ w_i\,\theta - \phi_i\ ).$$

13. The Wavefront Coding system of claim 11, wherein the the phase profile applied by the Wavefront Coding Optics substantially follows the function:

$$\mathrm{phase}(\rho,\theta) = \Sigma\ Q(\rho/\Omega_i)\ \mathrm{sign}_{angle}(\ M_i\,\theta - \mathrm{offset}\ )\ G\rho_i\ (\rho)$$

where $\mathrm{sign}_{angle}(\ \Phi\ ) = +1$ if $0 < \Phi < \mathrm{pi}$, $\mathrm{sign}_{angle}(\ \Phi\ ) = -1$ otherwise;

where the integer M controls the number of +/- sectors used around the circle, and offset controls the rotation of the +/- sectors.

14. The Wavefront Coding system of claim 13, wherein the the phase profile applied by the Wavefront Coding Optics substantially follows the function:

$$\text{phase}(\rho,\theta) = \Sigma \;\; Q(\rho/\Omega_i)\alpha_i \;\; \text{sign}_{\text{angle}}(M\theta \; - \; \text{offset}) \;\; [(\rho \; - \; \Omega l)/(1\text{-}\Omega l)]^{\beta i}.$$

15. The Wavefront Coding system of claim 13, wherein the the phase profile applied by the Wavefront Coding Optics substantially follows the function:

$$\text{phase}(\rho,\theta) = \;\; Q(\rho/\Omega) \;\; \text{sign}_{\text{angle}}(M \; \theta \; - \; \text{offset} \;) \;\; [(\rho \; - \; \Omega)/(1\text{-}\Omega)]^3.$$

16. The method of designing improved Wavefront Coding systems comprising the steps of:

designing Wavefront Coding Optics by -

selecting a central region of the Wavefront Coding Optics such that the central region applies an essentially constant phase profile to light passing through it;

selecting a peripheral region of the Wavefront Coding Optics such that the peripheral region applies a phase profile to light passing through it that alternately increases in phase and decreases in phase relative to the central region;

arranging the peripheral region such that the Wavefront Coding Optics are aspherical and rotationally nonsymmetric;

wherein the phase profile applied by the Wavefront Coding Optics alters the optical transfer function of the Wavefront Coding system in such a way that the altered optical transfer function is substantially less sensitive to focus related aberrations than was the unaltered optical transfer function; and

selecting a post processing function for processing images from the Wavefront Coding Optics by reversing an alteration of the optical transfer function accomplished by the Wavefront Coding Optics.

17. The method of claim 16 wherein the peripheral region applies substantially linear phase profiles.

18. The method of claim 17 wherein the peripheral region applies substantially cubic phase profiles.

19. The method for increasing depth of field and controlling focus related aberrations in an imaging system for imaging an object at a detector, the method comprising the steps of:

between the object and the detector, modifying the wavefront of light from the object;

the wavefront modifying step including the steps of applying an essentially constant phase profile to light passing through a central region and applying a peripheral profile that alternately increases in phase and decreases in phase relative to the central region to light passing through a peripheral region disposed about the central region;

the applying steps operating to result in an overall applied phase profile that is aspherical and rotationally nonsymmetric;

the applying steps operating to result in an overall applied phase profile that alters the optical transfer function of the imaging system in such a way that the altered optical transfer function is substantially less sensitive to misfocus related aberrations than was the unaltered optical transfer function;and

post processing the image captured by the detector by reversing the alteration of the optical transfer function accomplished by the the wavefront modifying step.

20. The method of claim 19, wherein the step of applying a peripheral profile applies substantially linear functions.

21. The method of claim 19, wherein the step of applying a

peripheral profile applies substantially cubic functions.